

**ECONOMIC EVALUATION AND LIMITATIONS  
MEASURING THE EFFECTIVENESS OF PREVENTIVE  
HEALTH CARE INTERVENTIONS**

Anttoni Aniebonam

*Bachelor's Thesis*

*Spring 2019*

---

**Title of thesis:** Economic evaluation and limitations measuring the effectiveness of preventive healthcare interventions

---

**Degree:** Bachelor of Science (Economics and Business Administration)

---

**Degree programme:** Economics

---

**Thesis advisor(s):** Pauli Murto, Mikko Mustonen

---

**Year of approval:** 2019

**Number of pages:** 28

**Language:** English

---

### Abstract

The world is being mauled by chronic illnesses and the ever-rising costs of healthcare. Researchers in the field of healthcare agree that chronic illnesses are mostly by their nature preventable. Despite all, preventive healthcare seems to not attract the interest amongst decision makers and aren't provided to the public nearly as much as curative healthcare services are. This literature review focuses on providing a wireframe like image of how economic evaluation is being conducted in the field of healthcare. This is done by introducing the most common tools thoroughly: COI, PCA, CEA, CUA and CBA, how these tools differ compared with one another and the limitations and assumptions that these tools and the current research methods face. By introducing these tools, and their limitations in capturing essential value and effectiveness of prevention, such as, preventions role in decreasing other co-morbidities and the effect of potential spillover effects, we look to encourage the further development of the existing process of conducting economic evaluation in the field of healthcare. Firstly, we assume that by all stakeholders in the field adopting a universal language of measuring cost-efficiency of prevention, and breaking a potential barrier of communication would result in wider adaption of prevention. Secondly by taking into consideration and by implementing the limitations of the tools currently used to develop future models, prevention effectiveness calculations in terms of their increased cost-efficiency could be presented in a better light to the deciding policymakers and would gain more interest amongst these stakeholders, which would ideally result in the increased provision of preventive healthcare services to the public in the future.

---

**Keywords:** Preventive healthcare, Economic evaluation, CBA, CUA, CEA

---

## Table of Contents

<b>1. Introduction.....</b>	<b>4</b>
<b>2. Definition, distribution and the development of preventive and curative health care ...</b>	<b>6</b>
2.1 Definition of preventive and curative healthcare.....	6
2.2 Current distribution of preventive and curative healthcare services .....	7
2.3 Recent development of preventive and curative healthcare services .....	7
<b>3. Methods of measuring the effectiveness of preventive healthcare interventions .....</b>	<b>8</b>
3.1 Economic Evaluation.....	8
3.1.1 Cost-of-illness analysis (COI).....	9
3.1.2 Programmatic cost analysis (PCA) .....	9
3.2 Prevention-effectiveness analysis methods.....	10
3.2.1 Cost-effectiveness analysis (CEA).....	11
3.2.2 Cost-utility analysis (CUA).....	13
3.2.4 Cost-benefit analysis .....	16
<b>4. Challenges related to economic evaluation in preventive healthcare interventions .....</b>	<b>18</b>
4.1 Randomized controlled trials as the status quo .....	18
4.2 Estimating the value for QALY .....	19
4.3 Estimating total lifetime costs.....	20
5.4 Estimating the outcomes of avoiding related comorbidities .....	21
5.5 Capturing spillover effects .....	22
<b>5. Conclusions.....</b>	<b>23</b>
<b>6. References.....</b>	<b>25</b>
<b>7. Figures .....</b>	<b>28</b>

# 1. Introduction

One of the biggest topics of interest globally amongst policymakers and researchers in the field of healthcare is the ever-rising cost of healthcare and the exponentially rising percentage of the population suffering from various kinds of chronic illnesses. According to OECD statistics expenditure in healthcare has grown almost 25% in the past 20 years.

Simultaneously, chronic illnesses are becoming more typical which are by their nature, preventable (Cohen & Neuman 2009). According to Wang (2018) chronic illnesses account for 60% of all deaths that occur in modern society. This makes chronic illnesses one of humankind's biggest threats. The threat that chronic illnesses pose towards modern society has grown into being a major topic of interest in the community of researchers, health economists and national organizations. Together these stakeholders are looking at ways that these diseases could be prevented. They aim to build strong economic cases to inform and reassure policymakers of the potential of preventive healthcare. Such studies have been conducted by multiple national organizations and researchers globally, such as McDaid et al. (2015) ; Haddix, et al. (2013) ; Cohen & Neumann (2009).

The cost-effectiveness of prevention is dividing opinions amongst the public. Some studies claim that preventive health care might not cut costs and thus the wide adaptation of preventive healthcare might not be beneficial, potentially increasing the total healthcare costs (Cohen et al. 2008). This has risen the interest of researchers in the field of health economics to study the tools of how economic evaluation generally in healthcare is being conducted and finding limitations of the current tools and study designs. By doing so, researchers in the field are looking to find value that is currently being excluded from these studies and thus developing better, more accurate methods for the use of researchers and policymakers. With developed more accurate tools and methods researchers are looking to shape the whole picture of the potential value that prevention might bring and thus engage a wider adaptation of prevention.

In this literature review, I look to examine how economic evaluation in the field of health care is conducted and tie this field of science into the observations and increased attention

towards the need of increasing the amount of preventive healthcare services. I look to study if partly the slow and moderately low adoption of preventive healthcare services might be caused by the limitations of these analysis methods used. Hypothetically, I assume that current research on the economic evaluation of preventative healthcare lacks the ability to fully capture the value that preventative healthcare would bring to society, and that unobserved value might be the reason for low cost-effectiveness found by multiple studies in the field.

I'll start this process by analyzing the distribution and development of preventive healthcare in developed countries. Secondly, I'll show how the burden of disease is validated to a given economy, and how potential costs of an intervention is thus being formed and what costs are taken into consideration when conducting such studies. In the third chapter, I look to show the analysis methods the researchers in the field are using in measuring the effectiveness of preventive interventions. How these methods differ from each other and, what models have reached the widest adaptation and why these models hold better in analyzing cost-effectiveness. In the fourth chapter I look to reveal the limitations of these methods, what benefits or increased effectivity these models don't take into consideration that could, if taken into consideration, promote the effectiveness of prevention compared to curative treatment methods.

## 2. Definition, distribution and the development of preventive and curative health care

### 2.1 Definition of preventive and curative healthcare

According to the World Health Organizations definition, preventive health care services can be divided into two subcategories – primary and secondary prevention. Primary prevention is defined as; “actions aimed at avoiding the manifestation of a disease” (WHO). This may include introducing new policies or education in changing the impact of social and economic determinants on health from an individual or communal level. Such interventions can be for example: nutritional and food supplementation, oral health, and dental hygiene or certain preventive interventions for individuals with communicable diseases. Secondary prevention is defined as early diagnosis and treatment of diseases that are still in the very early stages. Clinical examples of services that are in the realm of secondary prevention can be evidence-based screening for potential risk group for certain diseases from a population (WHO).

Preventive health care is a broad term that covers multiple levels and ways of reducing the likelihood of incidence of a disease. The term can include treatments varying from vaccination against polio to advanced regulation in the usage of seat belts, dietary restrictions and regulation in primary schools (Goetzel 2009).

Curative or rehabilitative care refers to medical practices in order to treat patients with existing diseases and helping to reach an optimal physical, sensory, intellectual, psychological and social function (OECD). Curative healthcare is optionally also referred to as treatment-based care in the field of health care.

## **2.2 Current distribution of preventive and curative healthcare services**

Distribution of healthcare between preventive and curative treatment methods in developed countries is significantly uneven. According to Wang (2018) the distribution of preventive and curative treatment varies significantly in developed countries. Wang conducted a study which looked at the distribution of preventive and curative treatment expenditure of the total healthcare costs relative to Gross Domestic Product (GDP), in 29 of all 36 OECD member countries. The expenditure of preventive and curative care was observed over the time period of 1998 to 2013 and an average estimate of the shares of expenditure between preventive and curative healthcare was formed from the data. The expenditure on preventive healthcare was the highest in New Zealand with 0.7% of GDP and lowest in the Slovak Republic, which was close to zero, 0.001%. Simultaneously, the expenditure of curative care was the highest in the United States 15.91% and lowest in South Korea at 3.62%. Looking solely at The United States which globally represents one of the biggest health care capitals in the world, their share in preventive health care services simultaneously in the same time period was approximately 0.5% of GDP (OECD statistics). This would mean that the U.S., representing one of the biggest health care countries, spends approximately 31 times more in treatment-based health care services, than preventive health care services.

## **2.3 Recent development of preventive and curative healthcare services**

Development of healthcare, in general, has grown significantly in the 2000s. The expenditure of healthcare in OECD countries grew from 2000 to 2017 by 23.6%. While at the same time the GDP in OECD countries two-folded (OECD statistics). Reasons for the growth of health care expenditure is usually explained by the growth of the aging population in developed countries and increased amount of non-communicable diseases and chronic illnesses.

According to Wang (2018) the development of preventive and curative health care has grown steadily in the past two decades in the previously mentioned OECD countries, prevention growing slower. The expenditure of curative healthcare from 1998 to 2013 grew from 7.62% to 9.08% on average. While preventive health care grew from 0.23% to 0.26% on average. Looking at the U.S. alone, the share of preventive healthcare expenditure over the past 20

years has slowly declined. The share of U.S. expenditure in preventive health care has declined from 1999 (3.99%) to 2013 (3.09%) (Wang et al. 2016). At the same time, The U.S. GDP per capita from 1999 to 2013 grew from 34478.0 to 53016.3 U.S. dollars (OECD statistics). Even though the GDP per capita has grown in the U.S. the supply of preventive healthcare services has not grown, but instead declined. These findings seem to be conflicted with findings conducted by many researchers. Even Wang's later conducted studies, which studied how the growth of GDP is positively correlated with the growth of preventive health care services after exceeding certain GDP per capita threshold. Developed countries, including the U.S. have by far passed this threshold. Simultaneously curative health care expenditure grew in the U.S from 1999 to 2013 by 30.4% (OECD statistics).

These findings indicate that the development of preventive healthcare services in developed countries seems to be increasing but by a much slower pace than curative health care services. In one of the biggest health care sectors in the world, The U.S., preventive healthcare services are declining, and far more resources are invested in curative treatment services.

### 3. Methods of measuring the effectiveness of preventive healthcare interventions

#### 3.1 Economic Evaluation

Economic evaluation is a stack of tools for analyzing which of the diseases and conditions in the general population are being the costliest to the society (Cost of Illness analysis). By comparing diseases and the associated costs with one another, economic evaluation looks to discover the most cost-effective way of treating a disease or condition. With limited resources, economists and policymakers agree on the fact that maximizing the population's health is important, but in the realm of scarce resources maximizing population's health, investing in healthcare must be done in a way that simultaneously minimizes the costs and maximizes the potential benefits. Economic evaluation helps us to understand the costs and the possible benefits of introducing a new intervention in healthcare. The needed tools in



regard to understand the process of economic evaluation are presented in the following sections.

### **3.1.1 Cost-of-illness analysis (COI)**

The first type of economic evaluation prior to the intervention is referred as economic impact analysis or often addressed among researchers in the field as Cost-of-illness analysis (COI). This analysis looks to discover the total cost of an existing disease or illness with the pre-existing ways of treating the disease, for example, costs occurring due to obesity in developed countries on a specific time frame. These calculations of costs usually take into consideration according to Haddix et al. (2013):

- Cost of direct medical expenses for the disease
- Cost of direct non-medical resources associated with the disease
- Indirect costs such as loss in productivity

COI works as a tool for policymakers and researchers in finding which diseases are the most costly and potentially hold a threat of having a wide impact on the population's health in the future, cause inefficiencies in the economic landscape in terms of lost productivity and it well indicates how health care resources are currently being allocated to different diseases and conditions. For example, in 1990 in the U.S. the cost of obesity was estimated to be around 68,800 million dollars with direct costs accounting for 67,3% including the high potential of obesity-associated risks and the remaining part 33.3% accounting for indirect costs that were mainly due to the loss in productivity (Wolf & Colditz 1994). COI is used in order to compare the burden of a variety of diseases in a given society with each other and can be used as a tool for policymakers and researchers for arguing and justifying the need for a possible intervention for certain diseases or improvements in the current treatments methods due to its high costs to the society (Haddix et al. 2013).

### **3.1.2 Programmatic cost analysis (PCA)**

After defining the COI of certain disease or condition in a given society on a specific time frame a detailed programmatic cost analysis (PCA) needs to be conducted. Programmatic

cost analysis is used to define all the costs associated in a certain intervention for existing disease or condition that is seen worthwhile after previously introduced COI analysis.

Programmatic costs can be divided into two subcategories (CDC<sub>b</sub>). Financial costs are all the costs or expenditure on resources that can be valued based on a market price. These are resources that are needed in order to implement the intervention, such as R&D, salary and supply costs. Economic costs are costs that don't necessarily have a market price but need to be included in the calculations in order to form more accurate cost estimates of the total costs implementing the program. For example, a given hospital could use a volunteering nurse appointed to the intervention program in other tasks that would accumulate value to the hospital. In order to capture all of the costs associated with the intervention, researchers need to use multiple sources and ways of analyzing the potential costs of resources. Salaries of personnel participating can be derived from accounting and payroll systems often on a highly detailed level. Cost of facilities and machinery usually hold a market price. Additionally, researchers can evaluate economic costs using questionnaires and observational data from the participants taking part in the experiment. Such economic costs could be for example traveling time to the research site or waiting time to treatment due to the low supply of the given treatment in its test phases.

After accurate estimation of the financial and economic costs associated with a program or intervention, we can move into comparing firstly the status quo treatment to a given intervention. Secondly comparing different interventions looking to tackle a given disease or condition with various ways of treatment with each other. Through comparing multiple interventions with one another, finally finding the best possible intervention that presents the most favorable cost saving or cost-effectiveness potential.

### **3.2 Prevention-effectiveness analysis methods**

The purpose of prevention-effectiveness analysis is to analyze the cost-effectiveness of a preventive intervention with the status quo treatment methods and to identify, measure, value and compare different possible interventions with each other. These analysis methods can be divided into two categories. Cost-effectiveness analysis (CEA) or Cost-Utility analysis (CUA), which reports a non-monetary value as an outcome, such as the “percentage reduction in certain condition” or “quality-adjusted life years saved”. Cost-benefit analysis

(CBA) reports simply a monetary value as an outcome. These are the most commonly used methods of validating the potential cost-effectiveness from a number of interventions in health economics (Haddix et al. 2013).

In our literature review, we look to focus mainly on the CUA and CBA analysis. These analysis methods are vastly used in the latest research, since they are robust and applicable to multiple conditions simultaneously, and their basic mechanisms differ from each other. We'll briefly describe CEA in order to get an understanding of how CUA differs from it and how can CUA be seen as more applicable in research of complex systems, a dynamically changing system with multiple components that affect each other such as health. This might be the reason why CUA is often used in the latest studies.

### 3.2.1 Cost-effectiveness analysis (CEA)

CEA is historically the most common analysis method in the field of health economics. CUA can be labeled under the CEA model which both report a non-monetary value as an outcome unlike CBA (Haddix et al. 2013). CEA reports health outcome of an intervention as a natural unit of measure such as “%- reduction of the population suffering from obesity” after treatment or a more generic outcome such as “life years gained” after the intervention. CEA is defined as dividing the net costs by the net effectiveness of a treatment intervention.

**Net cost** equals the cost of implementation or the calculated programmatic costs minus the costs averted through the preventive intervention.

(1)

$$NC = PC - COI$$

*NC = Net costs*

*PC = Programmatic cost of an intervention*

*COI = COI averted with new intervention*

A preventive care intervention that decreases the overall costs is referred to as cost-saving intervention. If benefits of certain preventive care interventions are sufficiently larger compared to its costs, the intervention is defined as cost-effective intervention even it wouldn't save money (Cohen & Neumann 2009). If net cost returns a negative value (positive value) the costs of the intervention are lower (higher) than the status quo treatment method.

In such cases, the cost-effectiveness is presented as net cost savings (cost-effectiveness ratio.).

**Net effectiveness** equals the health outcomes of putting in place the intervention minus the health outcomes without the intervention.

(2)

$$NE = O_A - O_B$$

*NE = Net effectiveness*

*O<sub>A</sub> = Health outcomes with the intervention*

*O<sub>B</sub> = Health outcomes without the intervention*

For example, in the case of preventing the occurrence of obesity, Outcomes A represents the hypothetically calculated average value of the potential change of obesity within the targeted group. Outcomes B represents the current change of obesity within the targeted group with the status quo treatment method.

Finally, if net costs equal a positive value the cost-effectiveness ratio (CE) is presented using the following formula (3):

(3)

$$CE = \frac{NC}{NE}$$

If the net costs equal a negative value the cost-effectiveness is presented as cost-savings and calculated with the following formula (4):

(4)

$$NCS = PC - COI$$

*NCS = Net cost saving*

*PC = Programmatic cost of an intervention*

*COI = COI averted with new intervention*

CEA or some of its modifications such as CUA are the most commonly used analysis methods in the field of health economics and economic evaluation calculations. A study conducted by Schwappach; Boluarte & Suhrcke (2007) showed that from 195 papers that studied the cost-effectiveness of cardiovascular disease interventions, CEA (reported as clinical outcome or as life years saved) was used as a primary economic evaluation method in 65% of all papers. In contrary Drummond et al. (2015) claim in their study that in more recent literature CEA is less used due to preferable method guidelines provided by Washington Panel and official requirements provided by the National Institute for Health and Care Excellence (NICE).

### **3.2.2 Cost-utility analysis (CUA)**

The Cost-Utility analysis (CUA) is used to determine the cost in terms of utilities measured in quantity and quality of life. CUA is used in order to make analysis outcomes of an intervention more generic compared to CEA which measures the health outcomes in purely natural units and is not comparable between two different health outcomes. The potential health outcomes of CUA are usually expressed in Quality of Adjusted Life Year (QALY) or Disability Adjusted Life Year (DALY).

A study conducted by Prieto & Sacristán (2003) well demonstrates how QALYs are calculated. QALY is a coefficient scale from 0 representing death to 1 representing a year in perfect health. A year lived in perfect health equals 1 QALY. A year lived in suffer, caused by a disease or condition that causes harm to the quality of life for example by 40% equals 0.6 QALY.

The value of QALY coefficient in a given health state is evaluated from the population or the intervention target group by multiple ways, such as Standard Gamble, Time Trade-Off, Rating Scale, or by means of pre-scored health state sorting systems (i.e. HUI, EQ-5D) (Prieto & Sacristán 2003). According to McDaid et al. (2015) in most developed countries, especially in the EU region QALYs are estimated using a EuroQol or EQ-D5™ evaluation questionnaire.

EQ-D5™ is a standardized instrument self-reported by the respondent to measure the current state of health in its respondents with various kinds of health diseases and conditions.

Information derived from the respondents' answers is evaluated as his or her health state on a scale from 0 to 1. These coefficients formed from the EQ-D5™ scale represent QALYs (Prieto & Sacristán 2003). The EQ-5D™ questionnaire has two sections, a panel of 5 standard questions: mobility, self-care, pain, anxiety, and daily activities and the other section consisting of a thermometer like single index (VAS) to value individuals current health state from 0 to 100 (McDaid et al 2015).

In order to perform a CUA and compare different treatment methods Prieto & Sacristán (2003) lists an example demonstration of CUA calculation in Figures 1 and 2. In their example they use two alternative treatment methods, their costs and QALYs gained through the treatment method. In the example, QALYs are estimated by treatment A increasing the quality of life from 0.5 to 0.9 and the quantity of life by 2 years (3.6 QALYs). The incremental costs are calculated by costs of treatment A (\$1500) minus the costs of treatment B (\$1000). Incremental outcomes, additional QALYs are calculated similarly.

Finally, CUA is calculated by dividing the Incremental costs with the incremental outcomes and reported as costs per QALY gained (\$192.31).

In other words, this analysis assumes that treatment A compared to treatment B would enhance the quality of life of an individual from 0.5 to 0.9 and add two more life years. This intervention would then cost 192.31 dollars per year.

#### Cost-Utility Example

TREATMENT	COST	OUTCOMES (QALYs*)
A	\$1500	3.6
B	\$1000	1
<b>Increment (of A over B)</b>	\$500	2.6
<b>Incremental cost/Incremental Outcome</b> \$500 / 2.6 QALYs = \$192.31 per QALY gained		

\*(3.6 QALYs = 4 years × 0.9 Units of Utility); (1 QALY = 2 years × 0.5 Units of Utility)

Figure 1. Cost Utility example. Source: Prieto & Sacristán (2003).

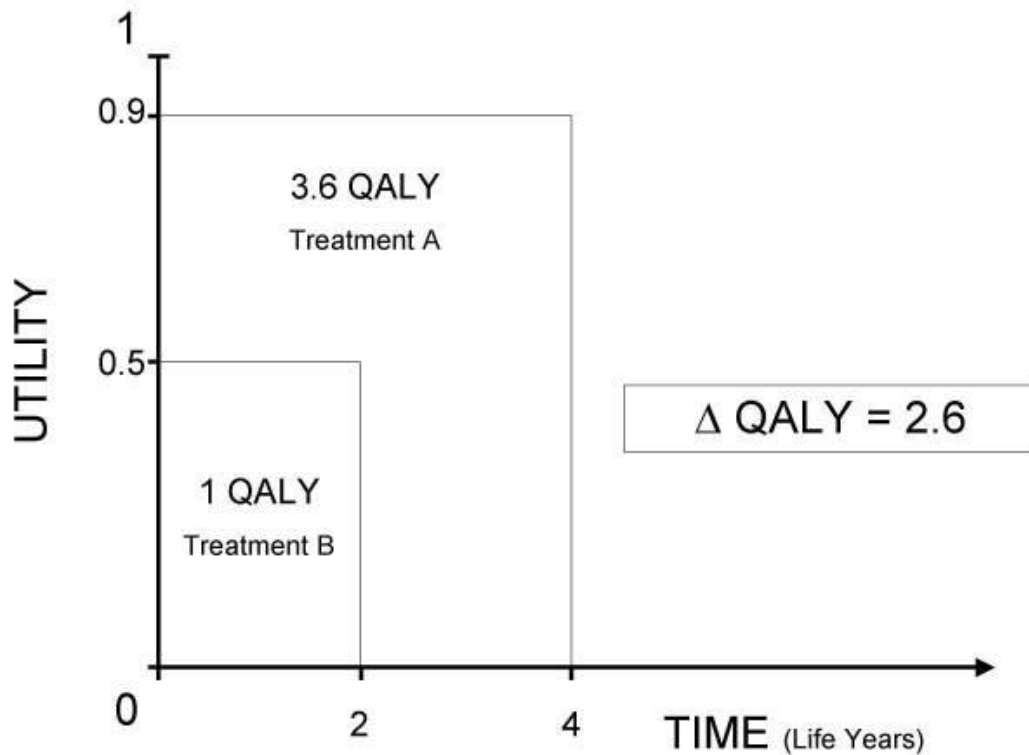


Figure 2. Cost Utility example visualized. Source: Prieto & Sacristán (2003).

CUA is the second most used analysis method in health economics. Many researchers suggest the usage of CUA and claims it is the best possible analysis method available (Robinson 1993; Drummond, et al 2015). From 195 cardiovascular disease interventions, 20% reported outcomes with CUA (Schwappach et al. 2007). Additionally, in high-income countries, QALY is the most commonly used generic outcome measure (Haddix et al. 2013).

CUA provides a generic measure of health outcomes (QALYs) for comparison of costs and outcomes between different programs (Drummond et al. 2015). This makes CUA more applicable and robust in analyzing the potential effectiveness and outcomes compared to CEA. CEA only reports the outcomes as natural units and leaves a lot of room in capturing the spillover effects of other comorbidities related to certain diseases. Additionally, CEA doesn't allow the simultaneous comparison of multiple interventions. Both CUA and especially CEA are hard to interpret by policymakers since they use non-monetary values as outcomes. We'll discuss more of this challenge in the next chapters.

### 3.2.4 Cost-benefit analysis

The Cost-Benefit Analysis (CBA) is often considered as the golden standard in basic economic evaluations (Haddix et al. 2013). The advantage of CBA is that it uses common metrics that can usually be expressed in monetary value, which enables effective ways of comparing a health care intervention and its costs and potential benefit in other societal sectors such as infrastructure, national defense and such. This is why CBA is mostly utilized amongst policymakers deciding where to invest and budget generally (CDC<sub>b</sub>). In contrary McDaaid et al (2015) argues that CBA method that often comes across in multiple economic evaluations is rarely used in the healthcare sectors, where evaluating benefits that incrementally increased health would achieve is challenging.

In terms of evaluating if certain preventive health care intervention has the possibility to return a positive investment CBA compares the society's willingness to pay for a certain health intervention with the opportunity costs. Such opportunity costs can for example present the lost monetary value that could have been used in something else what was sacrificed with the investment for a better health outcome.

In order to estimate the CBA of an intervention we need to map out the total future costs and the total future benefits associated with the intervention over time. Present values are calculated as following:

(5)

$$PV_C = \sum_{t=1}^T \frac{C}{(1+r)^t}$$

$$PV_B = \sum_{t=1}^T \frac{B}{(1+r)^t}$$

$PV_C$  = Present value of total future costs

$PV_B$  = Present value of total future benefits

$r$  = discount rate

$t$  = years of inspection

$T$  = total amount of years



Net present value (NPV) or a benefit-cost ratio (BCR) can be used in modeling CBA:

(6)

$$NPV = PV_C - PV_B$$

$$CBR = \frac{PV_C}{PV_B}$$

Measured in NPV, the invested health intervention is efficient if the present value of total future benefits exceeds the total future costs. This equals the net benefits. Measurement of net benefits can be then compared to other interventions and activities and seen which one of the possible interventions show the strongest proof of being efficient. Measured in CBR, values exceeding 1 show proof that the benefits of the calculated interventions exceed the potential costs.

CBA uses monetary values in both the numerator and divisor which makes its very nature different to CEA and CUA. CBA compared to other economic evaluation methods is more adjustable in comparing a wide range of public programs (Haddix et al. 2013). This makes it an often-used method amongst policymakers, which might cause a potential miscommunication between policymakers and researchers. While researchers are trying to find cost-effective interventions, policymakers are looking for cost-saving interventions (CDC<sub>a</sub>). This potentially leads into miscommunication between the two different parties and could be the reason for a slower adaptation of preventive healthcare services. Preventive healthcare services are often more costly on the surface as seen moderately in the example in figure 1 and 2 by Prieto & Sacristán (2003) but might have societal value and hold long term benefit to the society. Additionally, giving a monetary value for health benefits is a challenge the researchers using CBA tools usually face. Previously mentioned problems, as well as other limitations and challenges that cost-effectiveness analyses face will be discussed more throughout in the next chapters.

## 4. Challenges related to economic evaluation in preventive healthcare interventions

Many studies in the field of health economics have studied the challenges in economic evaluation of healthcare interventions such as Handels & Wimo (2019) ; Steel et al (2018). Many of these studies have had very similar kind of findings of the missing costs, potential effectiveness and value that these models are unable to capture. The studies analyzed and the economic evaluation methods used have challenges taking into consideration many key aspects that standard economic analyses should. According to Handels & Wimo (2019) the aspects the current models and research are having challenges to capture are; the long-term effects of prevention, if prevention saves money in the long term and how much do these interventions have an impact on the quality of life. Similar concerns were shown by Cohen & Neumann (2009) and the challenges of economic evaluation models estimating if the total lifetime costs of prevention would actually save money. Handels & Wimo (2019) highlight other factors such as; indirect effects on the quality of life through prevention, such as other diseases that may have an effect on the same time that certain condition is being treated. Other topics highlighted are the discounting rate over time, optimized target group and mapping all the intervention costs. Multiple researchers in previous studies in the field have studied and come across multiple other challenges about the economic evaluation which will be discussed in more detail in the following chapters.

### 4.1 Randomized controlled trials as the status quo

Randomized controlled trials (RCT) can be seen as a status quo in many fields of research. In the realm of healthcare randomized controlled trials can be seen as questionable way of conducting research. McDaid et al. (2015) argue that RCTs may have an effect and potentially damage the outcomes of the research. Randomizing patients within a treatment and control group may be challenging to implement when dealing with complex interventions and health-promoting interventions that happen in real life may be hard to control. Such interventions could, for example, be reducing cardiovascular disease with physical exercise. A control group having an exercise limit of 2 hours a week versus a treatment group with 4 hours a week. Is it appropriate and how realistic is it to limit the other groups exercise time

when the research is not being conducted in a laboratory setting? Many researchers have argued against such claims, stating RCT's being as applicable to healthcare than in any other field of research. For example, Rosen et al. (2006) argue that RCT's can be modified and designed in order to answer the needs of the research conducted and fit well into the realm of health care research.

Depending on how RCT's are being conducted, RCT's might steer the results of the cost-effectiveness of preventive treatment. While preventive health care services usually reap results after a long period of time, RCTs that have highly restricted variables, that need to be controlled over a long period of time, might inflate the programmatic costs of potential intervention and eat out some of the cost-effectiveness of the intervention and return unfavorable results before wider implementation of the intervention.

#### **4.2 Estimating the value for QALY**

In recent research, there has been a lot of criticism in terms of QALY and how it's evaluated. How should we estimate the quality of life measured and give QALY a value that can be compared to when conducting economic evaluation. How does one give a value for the quality of life, what are the factors that have an effect on a person's quality of life? McDaid et al. (2015) state that the main criticism towards QALYs in the field is due to the fact that QALYs only capture health-related quality of life, ignoring plenty of the other factors that may have an influence on one's assumption of "quality of life", such as education, safety, and other factors.

The threshold value range of QALY is 50,000 to 100,000 and this range of values is being used in the field of health care as a decision rule amongst policymakers (Cohen & Neumann 2009). Meaning that preventive interventions that represent lower QALY values, smaller than 50,000 to 100,000 per QALY would be seen as cost-effective, from the eyes of policy makers. Many researchers have criticized the threshold values claiming them to be too strict and suggesting of increasing the threshold value of QALY that seems to be undervalued in the modern era. Braithwaite et al. (2008) proposed after conducting a sensitivity analysis that raising the QALY threshold from range of 50,000-100,000 to 95,000 to 267,000 dollars per QALY would give a more realistic image of the value of one quality-adjusted life year in the modern era, claiming that the older values have been conducted and formed in much older era

of time and them lacking empirical proof. This might result the lack of preventive health care services being implemented, since the threshold values are so low that it's hard to find any cost-effective interventions that might represent such small values.

Also, some researchers have tackled and criticized the way QALYs are calculated. Prieto & Sacristán (2003) claimed that comparing time and quality is misleading and leads to contradicting results. Time and quality are very different types of parameters and should not be given a combined numerical coefficient or combined value since their very nature differs so much.

#### **4.3 Estimating total lifetime costs**

Estimating the total lifetime costs and benefits of prevention can be very challenging. In England when developing the National Institute of Health and Care Excellence (NICE) guidelines for evidence-based public health the estimation of time horizon and the causality between intervention and outcomes was described as one of the key challenges in economic evaluation (McDaid et al. 2015). Prevention and the intervention related may have a long time period before they demonstrate positive outcomes and the costs may be significantly higher in the beginning compared to the outcomes. The choice of time horizon in economic evaluation may drastically affect the outcomes of the cost-effectiveness analysis. McCreesh et al. (2018) studied how the choice of time horizon might hold a crucial effect on the effectiveness of prevention of HIV occurrence in Uganda. The study showed that intervention within 4 years from 2014-2018 didn't show drastic cost-effectivity but was very highly likely to be cost-effective in 2030. Many aspects need to be taken into consideration when estimating total lifetime costs, such as the used discount rates in a given analysis - how much are costs and benefits that would occur through the intervention within 30-50 years valued today? The use of optimal discount rates in economic evaluation is discussed in multiple studies, many researchers use the inflation-adjusted, long-term risk-free return on capital rate (3%). In each prevention intervention, depending on the researcher's choice, utilization and choice of discount rate may have a significant impact on the economic evaluation and the potential cost-effectiveness of estimation, especially in the long term.

Additionally, what Cohen & Neumann (2009) interpret as “competing risk” in their research is a significant factor looking at cost-effectiveness calculations and how they hold in general. Naturally increasing prevention-based treatment makes populations less prone to variety of chronic diseases and enables people to live longer. This means that the life-span of humans would increase, which has inarguably been one of the humankind's biggest achievements. Looking at this matter from an economic and societal perspective provides an alternative and arguing viewpoint on the matter. Added life years comes with a price, the price of additional costs and an overall economic burden to society. Prevention adds life years and these added life years especially in the late years can be extremely costly to the society. According to Alemayehu et al. (2004) annual healthcare costs start rising exponentially after the age of 50 and comparing 85 years or older to 75-84 years old population the annual health care costs are twice as much in the former group. Prevention effectiveness thus depends on how much prevention in the population that the intervention is targeted can in earlier phases of their lifetime decrease direct costs occurring from a variety of preventable diseases and conditions and indirect costs such as productivity losses.

#### **4.4 Estimating the outcomes of avoiding related comorbidities**

Many of the current analysis methods related to the effectiveness of prevention interventions are lacking the capability of capturing the potential savings of avoiding comorbidities related to certain diseases or condition if the intervention is set in place. In other words, for example preventive interventions targeted to decrease the occurrence of Diabetes Mellitus Type 2 in adolescents by recommending and increasing physical activity and recommending cleaner diet might lower the risk of hypertension and cardiovascular diseases and countless of other conditions. If such analysis was conducted and one would be able to analyze the costs averted by avoiding the occurrence of related comorbidities the cost-effectiveness analysis would show much more positive results, than the current models that usually measure one condition or disease at a time as is seen in CEA's, which reports outcomes in natural units one condition at a time. CUA analysis can be argued to capture this since it converts the natural units of outcomes to QALYs and captures through earlier discussed methods such as EQ-5D™ the state of populations health with a certain disease. This in some extent might take into consideration the most common comorbidities related to certain condition that is the reflected to the value that people suffering from the condition answer their current health status.

## 5.5 Capturing spillover effects

Capturing spillover effects of either from an existing condition or spillover effects that are caused or are a result of preventive healthcare interventions is a vastly researched topic such as Basu & Meltzer. D. (2005); Prosser et al. (2014). It's described by many researchers as a challenging task to capture and is thus often disregarded in economic evaluation. Including or excluding the analysis of potential spillover effects might change drastically the cost-effectiveness ratio of an intervention. Al-Janabi et al. (2016) measured the spillover effects in families that had one member of the family that suffered from meningitis, acute inflammation of membranes covering the brain. They found that the closest and even some distinct family members suffered from various kinds of health issues and overall health status loses measuring health status with the EQ-D5™ questionnaire. The research reported that vaccinating against meningitis would increase the health status of the family members network by 16% or 0.041 annual QALYs. Estimating spillover effects in examples like such and the costs that such conditions in a family network might cause to the society should be taken into consideration in COI analysis but rarely are. This could drastically change the results of how severe some of the diseases are and encourage towards the adaption of prevention.

We can analyze potential spillover effects from another perspective as well. How much would introducing a preventive intervention to treat certain condition impact on the whole society through close members of the targeted individual or population? McDaid et al. (2015) in their report argue that adding preventive healthcare services might have a positive effect on the broader population through close family members adapting, for example, a certain kind of lifestyle and influencing other people around them to take similar actions. These kinds of factors aren't usually taken into consideration in economic evaluation since research as such is challenging to conduct and additionally is likely to be highly expensive eating out the cost-effectiveness of a given intervention, since these costs would be naturally calculated to the total costs.

## 5. Conclusions

This literature review illustrates the current state of preventive healthcare in developed countries, the tools which economic evaluation is being conducted in the field as well as the limitations of these tools and common pitfalls in measuring the costs and outcomes of healthcare interventions. This study proposes that the lingering reason for the poor adoption of preventive health care services provided to society is due to the fact that the economic evaluation and research conducted in the field are lacking the ability to capture some of the underlying value and factors affecting society's health analyzed in Chapter 4 and 5. The research and existing tools seem lack the ability in capturing the potential value that prevention could potentially create. How prevention might affect more efficiently in curing other comorbidities associated with a certain disease, compared to treating a specific disease with treatment-based methods. How prevention might have an effect on the general population through a multiplying factor, influencing as an example, better lifestyle choices to family members extending from them to even further (McDaid et al. 2015). Additionally, these tools and research seem to have problems in estimating the total costs over long periods of time that prevention might take in order to manifest positive results as seen in the example in chapter 5 preventing the occurrence of HIV in Uganda. (McCreesh et al. 2018).

Secondly, between multiple stakeholders, researchers, economists, and policymakers involved in the field exists a barrier of communication of the ways how the effectiveness of prevention is being measured discussed in chapter 3.2. While policymakers are looking for solutions that would save costs researchers and economists are trying to find the most cost-effective preventive interventions that don't necessarily save money but are indeed cost-effective (Cohen & Neumann 2009). Recognizing the limitations of these tools, taking them into account and breaking the barrier of communication by forming a mutual understanding and common guidelines of measuring the cost-effectiveness of preventive healthcare hopefully will lead to wider adoption of these services in the future.

The development of preventive healthcare is slowing down (Wang 2018) and even the cost-effectiveness and the possible improvements prevention could provide is heavily studied and suggested amongst researchers, prevention is not being implemented on the magnitude that researchers in the field are proposing. The goal of my research is to raise a concern, a concern about the lack of resources invested in preventive healthcare services. I look to raise awareness on the topic by providing a wireframe like description of the tools used in the field of health economics, by introducing the currently used analysis methods, limitations of these methods and the usual pitfalls in designing research settings related to prevention effectiveness studies.

With providing this information I look to inspire and promote on further research of the topic, leading to the urge of developing more suitable models in economic evaluation that would better fit to the field of healthcare, taking into consideration some of the limitations and assumptions addressed in this literature review. I assume and wish this would lead to more favorable results in terms of the effectiveness of prevention, and finally a wider adoption of preventive health care services in the future.



## 6. References

Alemayehu. B. & Warner. K. (2004). The Lifetime Distribution of Health Care Costs. *Health Services Research* vol. 39, no. (3): 627–642.

Al-Janabi, H.; Van Exel, J.; Brouwer, W.; Trotter, C.; Glennie, L.; Hannigan, L. & Coast, J. (2015). Measuring Health Spillovers for Economic Evaluation: A Case Study in Meningitis. *Health economics*, 25(12), 1529–1544. doi:10.1002/heh.3259

Basu. A. & Meltzer. D. (2005). Implications of spillover effects within the family for medical cost-effectiveness analysis. *Journal of Health Economics*, 24(4): 751-773

Braithwaite. R.; Meltzer. D.; King. J.; Leslie. D. & Roberts. S. (2008). What does the value of modern medicine say about \$50,000 per quality adjusted life year decision rule. *Medical Care*. 46(4): 349-356.

CDC<sub>a</sub> (2017). Part I: Introduction to Economic Evaluation.

[https://www.cdc.gov/dhds/evaluation\\_resources/economic\\_evaluation/docs/Economic-Evaluation-Part1.pdf](https://www.cdc.gov/dhds/evaluation_resources/economic_evaluation/docs/Economic-Evaluation-Part1.pdf)

CDC<sub>b</sub> (2017). Part III: Programmatic Cost Analysis.

[https://www.cdc.gov/dhds/evaluation\\_resources/economic\\_evaluation/docs/Economic-Evaluation-Part3.pdf](https://www.cdc.gov/dhds/evaluation_resources/economic_evaluation/docs/Economic-Evaluation-Part3.pdf).

Cockcroft A (2017). Randomised controlled trials and changing public health practice. *BMC Public Health*. 2017;17(Suppl 1):409. Published 2017 May 30. doi:10.1186/s12889-017-4287-7

Cohen. J. & Neumann. P. (2009) Cost Savings and Cost-Effectiveness of Clinical Preventive Care. *The synthesis project, Robert Wood Johnson Foundation*. No 18: 1-19.

Cohen. J.; Neumann. P. & Weinstein. M. (2008). Does Preventive Care Save Money? Health Economics and the Presidential Candidates. *N Engl J Med*: 661-663

Drummond. M.; Sculpher. M.; Claxton. K.; Stoddart. G. & Torrance. G. (2015). Methods of Economic Evaluation of Health Care Programmes. 4rth edition. Oxford University Press.: 1-36.

Goetzel. R. (2009). Do Prevention or Treatment Services Save Money? The Wrong Debate. *Health Affairs*. 28:1: 37-41

Haddix. A.; Teutsch. S. & Corso. P. (2002) Prevention Effectiveness A Guide to Decision Analysis and Economic Evaluation. 2nd edition. Oxford University Press.: 3-28.

Handels. R. & Wimo. A. (2019) Challenges and recommendations for the health-economic evaluation of primary prevention programmes for dementia. *Aging & Mental Health*. 23:1: 53-59.

Maciosek. M.; Coffield. B.; Flottemesch. T.; Edwards. N. & Solberg. L (2010). Greater Use Of Preventive Services In U.S. Health Care Could Save Lives At Little Or No Cost. *Health Affairs* 29:9: 1656-1660.

McCreesh. N.; Andrianakis. I.; Nsubuga. R.; Strong. M.; Vernon. I.; McKinley. T.; ... & White. R. (2018). Choice of time horizon critical in estimating costs and effects of changes to HIV programmes. *PloS one*. 13(5): 1-10

McDaid. D.; Sassi. F. & Merkur. S. (2015) Promoting Health, Preventing Disease The economic case. European observatory on health systems and policies series. *Open University Press*: 3-50

OECD (2013). OECD Health Data 2013 Definitions, Sources and Methods.  
<http://stats.oecd.org/fileview2.aspx?IDFile=960109d9-0f06-4b8a-9715-3dfad3e35a8a>.

OECD statistics (2019). OECD.stat. <https://stats.oecd.org/>.

Prieto. L. & Sacristán. J. (2003). Problems and solutions in calculating quality-adjusted life years (QALYs). *Biomed Central*, 1:80.

Robinson. R. (1993). Cost-Utility Analysis. National Center for Biotechnology Information. *BMJ* volume 307: 859-862.

Rosen. L.; Manor. O.; Engelhard. D. & Zucker. D. (2006). In defense of the randomized controlled trial for health promotion research. *Am J Public Health*. 2006;96(7):1181-6.

Schwappach. D.; Boluarte. T. & Suhrcke. M. (2007). The economics of primary prevention of cardiovascular disease – a systematic review of economic evaluations. *Biomed Central* 5:5.

Steel. J.; Godderis. L. & Luyten. J. (2018). Methodological Challenges in the Economic Evaluation of Occupational Health and Safety Programmes. *International Journal Environmental Research and Public Health*. 15: 1-12.

Wang. F. (2018) The roles of preventive and curative health care in economic development. *PloS one* 13(11): 1-2.

Wang. F.; Wang. J. & Huang. Y. (2016) Health expenditures spent for prevention, economic performance, and social welfare. *Health Econ Rev* 6:45.

WHO (2019). Health promotion and disease prevention through population-based interventions, including action to address social determinants and health inequity.  
<http://www.emro.who.int/about-who/public-health-functions/health-promotion-disease-prevention.html>.

## 7. Figures

**Figure 1.** Cost Utility Example. Source: Prieto. L. & Sacristán. J. (2003). Problems and solutions in calculating quality-adjusted life years (QALYs). *Biomed Central*, 1:80.

**Figure 2.** Cost Utility Visualization. Source: Prieto. L. & Sacristán. J. (2003). Problems and solutions in calculating quality-adjusted life years (QALYs). *Biomed Central*, 1:80.